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JUL 79 J D STALLER, J S LAPPIN, R FOX N00014-76-C-1101
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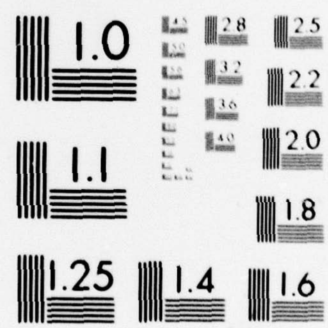

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LEVEL II

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The effect of prior knowledge on the time required to classify letters was examined for two classes of letters: (a) Letters presented stereoscopically as random-element stereograms, and (b) letters presented as two-dimensional physical contours. The variables of stimulus discriminability (stereoscopic vs. physical contours) and stimulus uncertainty were combined factorially. Stereoscopically presented letters were classified more slowly, but stimulus uncertainty had the same effect for both stereoscopic and

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physically defined letters. The additivity of these two variables indicates that the perception of stereoscopic forms is an automatic process not influenced by cognitive variables.

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INTRODUCTION

Is the time required to perceive global stereopsis affected by uncertainty about the form to be resolved?

When a naive observer first views a random-element stereogram perception of the stereoscopic form often requires several seconds, but after additional presentations of the stereogram the time required for perception decreases dramatically. Furthermore, anecdotal reports suggest that stereoscopic form perception may be enhanced when observers are given prior information about the shape of the stimulus to be resolved. Thus, as Julesz (1971) has pointed out, the relatively slow perceptual resolution of random-element stereograms may be sensitive to effects of cognitive processes that are difficult to detect with more conventional stimulus displays.

Previous studies on the time required to perceive random-element stereoscopic forms (Frisby & Clatworthy, 1975; MacCracken, Bourne, & Hayes, 1977; MacCracken & Hayes, 1976; Ramachandran, 1976; Ramachandran & Braddick, 1973; Saye & Frisby, 1975) have all used the same basic procedure. Naive observers are presented with random-element stereograms and asked to report when they perceive a form. The procedure is repeated 5 to 30 trials, with the same stereogram presented on every trial. The universal finding is that the time to perceive the stereo form decreases over trials, often by more than a factor of ten. Thus, stereopsis produced by random-element stereograms is facilitated by practice.

In addition to practice effects, two studies have explored the effects of prior knowledge on stereoscopic form perception. Frisby and Clatworthy (1975) gave three groups of naive observers one of three kinds of information about the form they were about to see. The information was a verbal description, a monocular cue embedded in the stereogram, or a three-dimensional model of the form. All groups showed improvement with practice, but barely more than did a control group that received no prior knowledge. The statistical analysis of these data indicated no significant advantage from any of these types of information, although a subsequent reanalysis by Cleveland and Guarino (1978) did reveal a small yet statistically reliable benefit from prior knowledge. In a supplementary experiment Saye and Frisby (1975) found that monocular cues speeded the perception of stereograms with large disparity values, an effect they suggest may be due to the induction of appropriate convergence eye movements.

The methodology of these studies, however, does not permit firm conclusions about the specific process that has been influenced by the viewing experience or prior knowledge. Because the same stereograms were presented repeatedly, knowledge about the shape and location of the target form was confounded with practice effects. Further, the fact that observers were fully aware of the stereoscopic form to be resolved makes it necessary to place great reliance on their ability to maintain a constant response criterion.

The design of the present experiments represents a straightforward extension of the additive-factors method developed by Sternberg (1969), in which the number of alternative targets and type of stimulus presentation was systematically varied. Since it was known that reaction time for classifying a target form would be affected by both the number of possible targets and by the stimulus type (random-element stereograms take longer to resolve than conventional physical-contour forms), the strategy was to determine whether these two variables were additive or interactive.

If the speed of stereopsis is unaffected by prior knowledge about the target form, then the effect of increasing the number of alternative target forms should be the same for both stereoscopic and physical contours--stimulus uncertainty and stimulus type should have independent and additive effects on target classification time. If, however, stereopsis is influenced by prior knowledge, then the increase in reaction time from increasing stimulus uncertainty should be greater for stereoscopically than for physically defined forms. Thus, an additive outcome would indicate that the speed of stereopsis is not influenced by prior knowledge about the target form, while an interaction would suggest that stereopsis is facilitated by prior knowledge.

In the following experiments reaction time varied as a function of the number of target alternatives as well as stimulus type, but these variables did not interact. The conclusion is that prior knowledge about the target form did not influence the speed of resolution of global stereopsis.

EXPERIMENT 1

Stimulus type (stereoscopic or physical contours) and number of alternative targets (2 or 8 letters) were combined factorially. Response time varied as a function of both variables, but there was no interaction between them.

METHOD

Subjects. Four volunteers from the Vanderbilt community served individually. All were paid $3 per session and had prior experience with random-element stereograms.

Stimuli and apparatus. The stimuli were ten letters of the alphabet (M, R, Y, B, K, X, G, C, H, N) presented individually on a modified color television display (Advent 1000) either as random-dot stereograms or as two-dimensional physical contours.

The random-dot stereograms were generated by a system similar to that described by Fox, Lehmkuhle, and Leguire (1978). In brief, the system generates large matrices (+30,000 cells) of red and green dots that are completely replaced every 16 msec with a new randomly selected set of dots. The rapid replacement of dots produces an incoherent apparent

movement similar in appearance to dynamic video noise. While the movement does not prevent perception of stereoscopic forms, it does eliminate potential monocular cues. Stereoscopic presentation was implemented by a specially designed electro-optical device that has the capability of converting any two-dimensional shape into its stereoscopic counterpart. It does this by programming or specifying the X-Y positions in the display where disparity is to be introduced. In this application, the shapes were letters projected by a 35-mm slide projector onto a screen that was scanned by the electro-optical programmer and then the stereoscopic counterpart of that letter was generated on the color television display. The anaglyph method (Woodworth, 1938) was used to produce the dichoptic stimulation required for stereoscopic presentation, wherein observers viewed the display through red and green filters (Wratten 58 and 26) that physically segregated the dot matrices so that only one matrix, red or green, stimulated a single eye. The stereoscopic letters, which were 7 deg high and 5-9 deg wide, were presented in crossed disparity (disparity 27'30"), i.e., they appeared to lie in front of the projection screen.

The letters presented as two-dimensional physical contours were identical in size and configuration to the stereoscopic letters. Indeed, the physical letters were produced by taking signals from the electro-optical device and selectively suppressing dots electronically so that the final displayed product was a black, dot-free figure against a red dot background.

Procedure. Observers participated in two daily one-hour test sessions. Half the observers viewed the dynamic stereograms in the first session and the two-dimensional physical contours in the second session; the other half viewed the physical targets first. Within each test session there were four blocks of test trials with 48 trials per block. The number of alternative targets--2 or 8--was constant within a trial block and alternated between blocks. A single target letter was presented on each trial, and observers responded by classifying it into one of two sets. Half of the letters were designated set "one" and half set "two." Stimulus-response mapping was counterbalanced across observers and consistent for each observer throughout testing.

The sequence of events on each trial was as follows: The experimenter signalled that a trial was about to begin; the observer depressed a telegraph key and a homogeneous background field of dots appeared (red for the physical targets, red and green for the stereograms); 1 sec later the test stimulus appeared, superimposed on the background; 4 sec later the display was turned off. The observer was instructed to release the telegraph key as soon as he was able to classify the target; simultaneous with key release the observer said "one" or "two" aloud. Reaction time was measured from the onset of the test stimulus to the release of the observer's key. Stimuli were presented in a pseudo-random order and the intertrial interval was about 10 sec. The display was binocularly viewed in a dimly lighted room from a distance of 12.5 ft. and the observer wore chromatic filters while viewing the stereograms. Prior to testing the observer memorized the stimulus-response mapping and was given brief practice.

RESULTS

Mean reaction time as well as mean error percentage values are shown in Figure 1. Observers responded more quickly to the physical contours ($\bar{X}$ = 457 msec) than to the stereoscopic ones ($\bar{X}$ = 709 msec), $F(1, 3) = 10.93$, $p < .05$. Responses were also quicker when there were two target alternatives ($\bar{X}$ = 500 msec) than when there were eight ($\bar{X}$ = 666 msec), $F(1, 3) = 282.98$, $p < .001$. There was no interaction between the type of stimulus and number of targets, $F < 1.0$, and no other reaction time effects were significant, all $p > .25$. The overall error rate was low (2.8%) and in accord with the raction time findings.

EXPERIMENT 2

In Experiment 1 the effect on reaction time of the number of possible targets was the same for both physically and stereoscopically defined targets. Experiment 2 explored the generality of this finding with other observers, more variation in the number of targets, different target letters, and a nonverbal response measure.

METHOD

Subjects. Five new volunteers from the Vanderbilt community served individually. All received $3 per session and had prior experience with random-element stereograms.

Stimuli and apparatus. The stimuli were fourteen letters (H, Y, W, P, N, Z, L, C, F, K, J, D, X, R) presented by the same apparatus and technique described above.

Procedure. Observers participated in one practice session followed by three daily one-hour test sessions. Within each session there were 6 blocks of trials, with 32 trials per block. The number of alternatives--2, 4, or 8--was systematically varied between trials blocks. In contrast with Experiment 1, observers responded by releasing one of two telegraph keys to signify one set or the other. Target alternatives were changed every 32 trials and stimulus type was changed every 96 trials. The order of experimental conditions was counterbalanced as much as possible. Observers wore chromatic filters throughout the entire test session. All other procedural details were the same as in Experiment 1.

RESULTS

Mean reaction time as well as mean error percentage values are shown in Figure 2. All observers responded more quickly to physical contours ($\bar{X}$ = 383 msec) than to stereoscopic ones ($\bar{X}$ = 445 msec), $F(1, 4) = 14.73$, $p < .05$. Interestingly, some observers with considerable previous stereogram experience responded almost as quickly to the stereograms as to the physical forms--a difference of only about 30 msec.

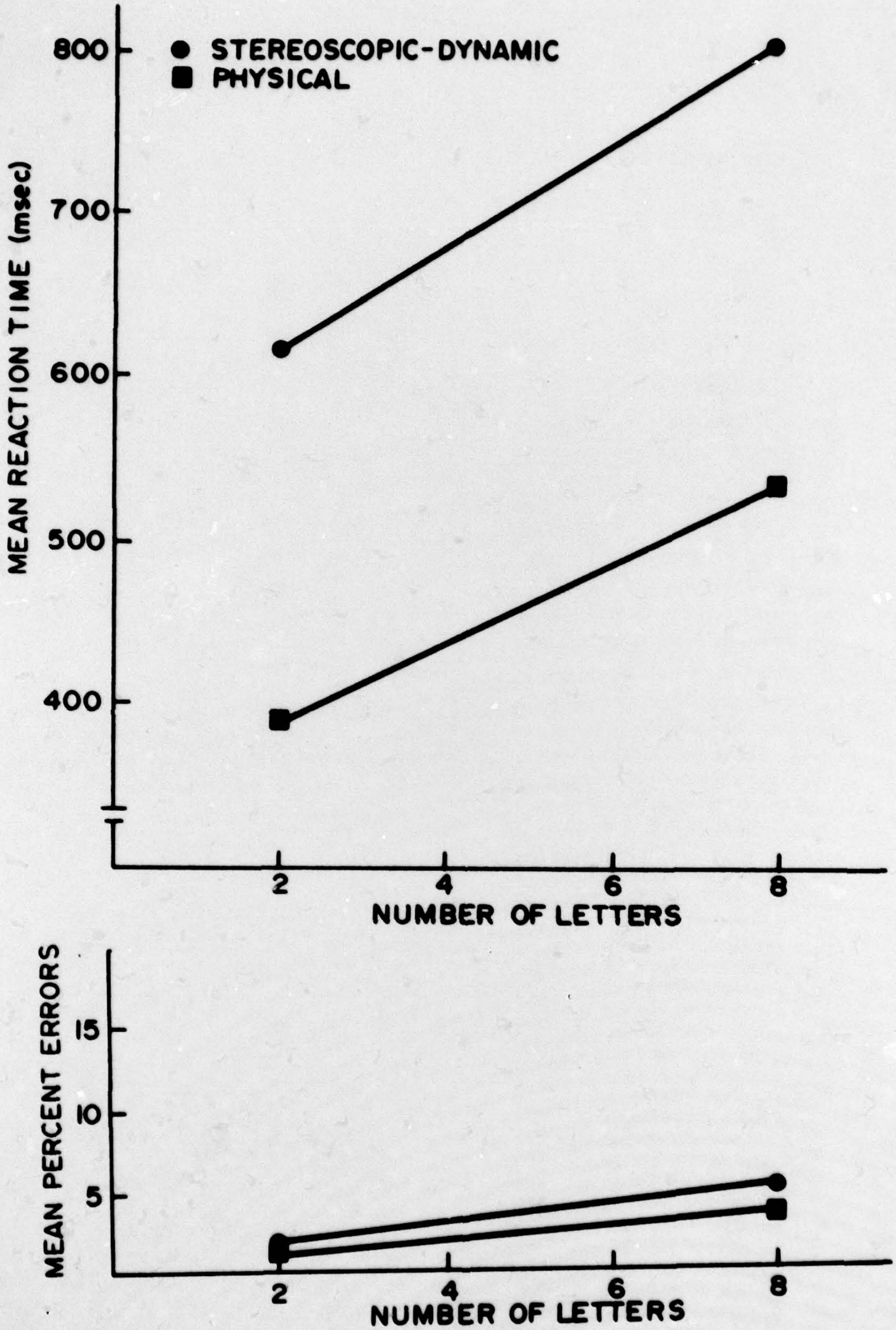

Fig. 1. Mean response times and mean percent errors (Experiment 1) for dynamic stereograms and physical contours at two levels of stimulus uncertainty (2 vs. 8 letters).

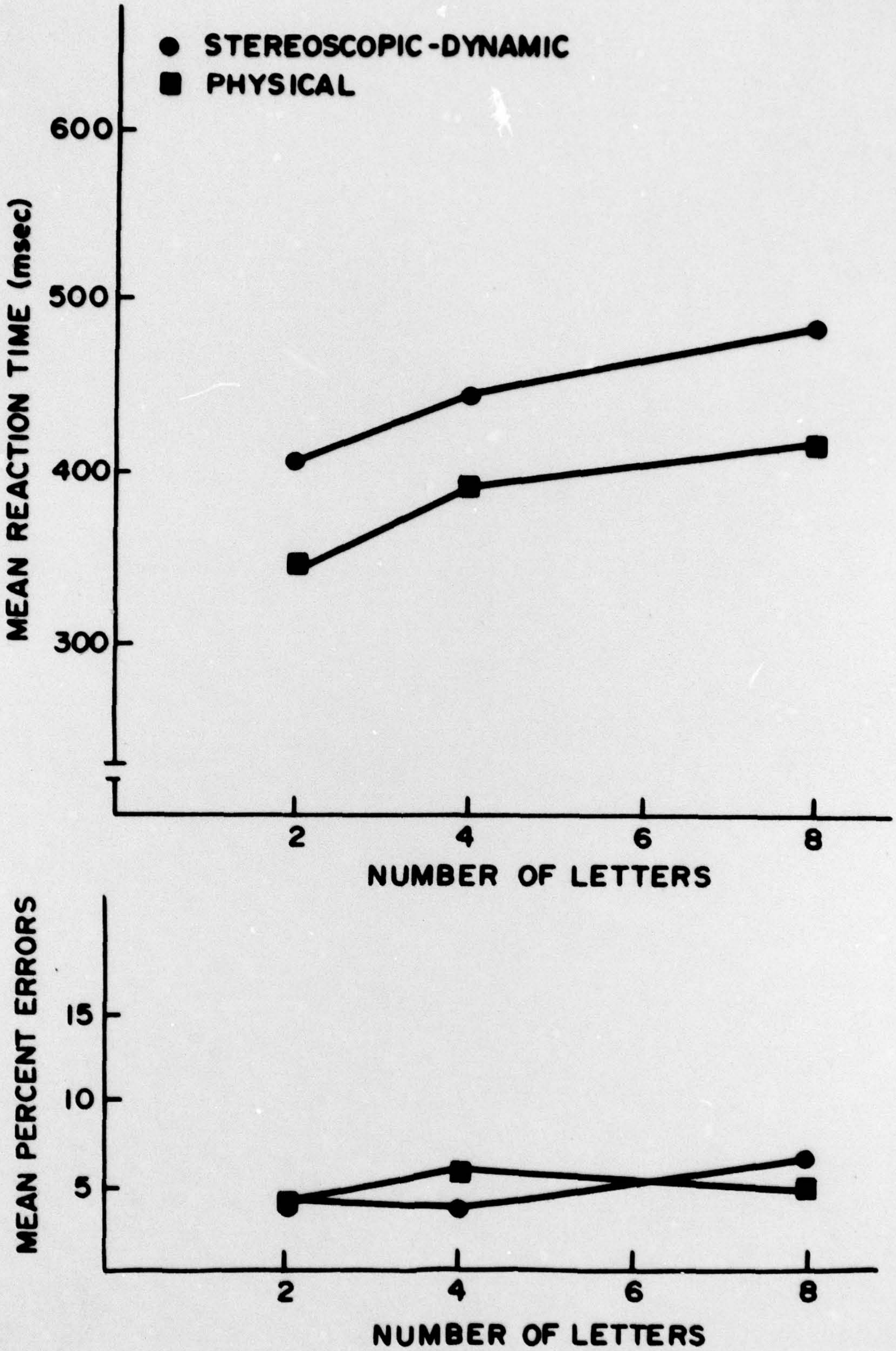

Fig. 2. Mean response times and mean percent errors (Experiment 2) for dynamic stereograms and physical contours at three levels of stimulus uncertainty (2 vs. 4 vs. 8 letters).

Response times also varied as a function of the number of possible targets, $F(2, 8) = 30.26$, $p < .001$, and subjects improved with practice, $F(2, 8) = 21.14$, $p < .001$. Furthermore, there was an interaction between number of possible targets and practice, $F(4, 16) = 3.9$, $p < .05$, due to greater improvement in the 8-letter condition than in the 4- or 2-letter conditions.

As in Experiment 1 there was no interaction between number of target alternatives and stimulus type, $F < 1.0$, and no other reaction time effects were significant, all $p > .25$. The overall error rate was low (4.6%), and there were no large error differences between conditions.

EXPERIMENT 3

In both Experiments 1 and 2 the effect of the number of alternative targets was the same for both stereoscopic- and physical-contour stimuli, a result which indicates that prior knowledge does not influence the speed of stereopsis. In Experiment 3 we tested the generality of this conclusion with two different types of stereograms--static and dynamic. Previous research by Julesz (Julesz & Kropfl, 1973, Note 1) as well as in our own laboratory had indicated that dynamic stereograms were more slowly resolved than static ones, and it seemed possible that prior knowledge might have a differential effect on perception of these two types of stimuli. Again, however, the effect of target uncertainty was the same for both stimulus types, even though the dynamic patterns were responded to more slowly by all observers.

METHOD

Subjects. Five new volunteers from the Vanderbilt community served individually. Four received \$3 per session and one received class credit. None had participated previously in an experiment on stereopsis.

Stimuli, apparatus, and procedure. Letter targets were presented as either dynamic or static stereograms. The dynamic stimuli were the same as those used in Experiments 1 and 2--the individual dots appeared to move. In contrast, the position of dots in the static stereograms remained constant throughout a test trial. In all other respects the stimuli, apparatus, and procedure were the same as in Experiment 2.

RESULTS

Mean reaction time as well as mean error percentage values are presented in Figure 3. All five observers responded more quickly to static stereograms ($\overline{X} = 466$) than to dynamic ones ($\overline{X} = 586$), although this difference was not significant by analysis of variance, $F(1, 4) = 2.98$, $p < .15$. Observers also responded more quickly when there were fewer stimulus alternatives, $F(2, 8) = 44.97$, $p < .001$, and performance improved with practice, $F(2, 8) = 8.32$, $p < .05$. There was no interaction between number of stimulus alternatives and stimulus type,

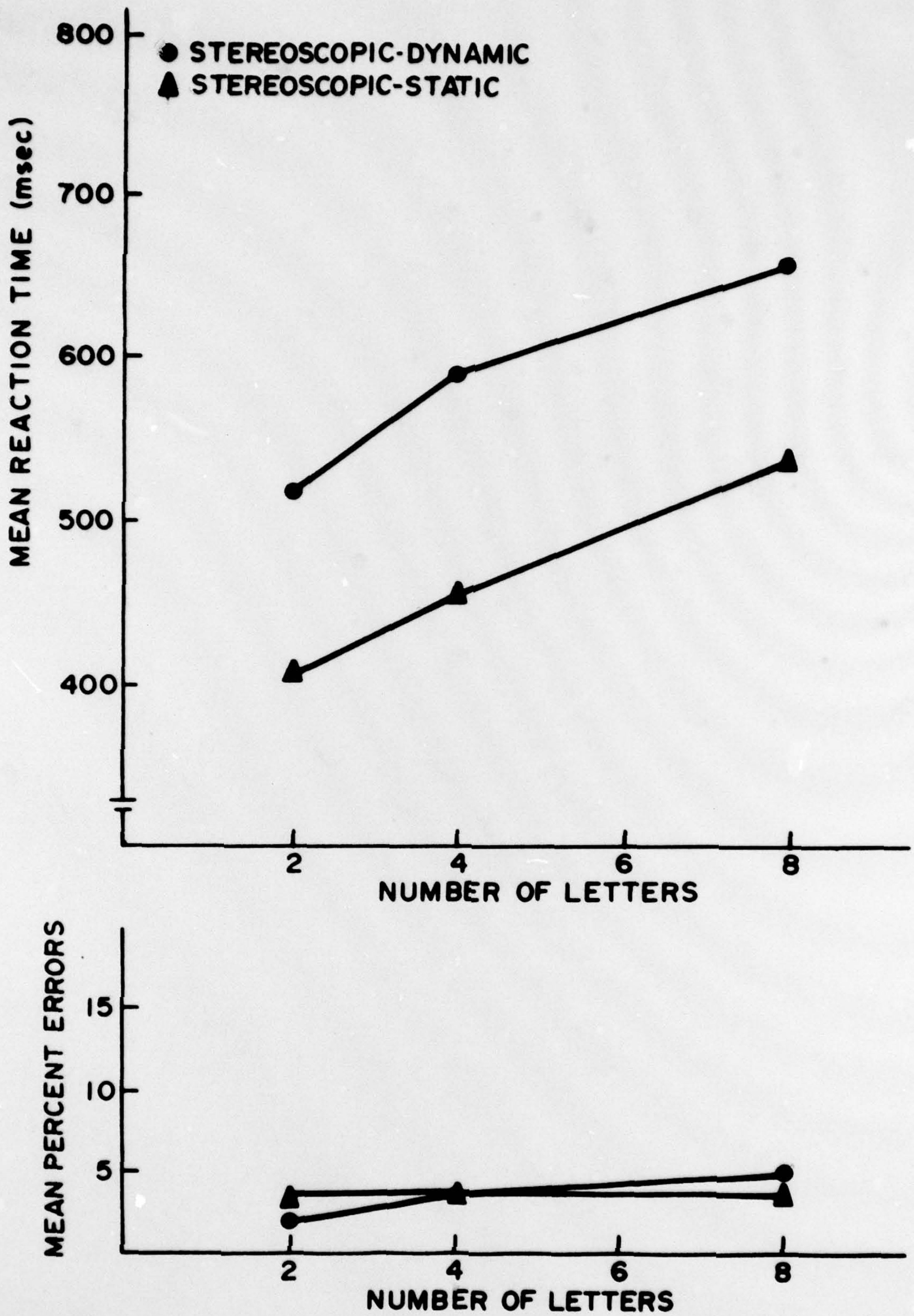

Fig. 3. Mean response times and mean percent errors (Experiment 3) for dynamic and static stereograms at three levels of stimulus uncertainty (2 vs. 4 vs. 8 letters).

$F < 1.0$. No other effects of the reaction time analysis were significant, all $p < .1$, with the exception of the stimulus type by number of alternatives by practice interaction, $p < .083$.

The overall error rate was low (3.5%) and there were no large error differences between conditions.

DISCUSSION

The results of all three experiments indicate that increasing the number of stimulus alternatives produces the same increment in reaction time for each of the three stimulus types used--dynamic random-element stereoscopic forms, static random-element stereoscopic forms, and physical-contour forms. That is, the functions defining these stimuli had the same slope, and interactions among them were not detected. There were, however, significant differences in discriminability among the stimulus types, as revealed by differences in reaction time (i.e., the reaction time intercept). This pattern of results is anticipated by the Sternberg additive-factors approach outlined in the introduction, and suggests two independent information-processing stages--an initial stage, with information encoding, represented by the reaction time intercept, and a subsequent second stage of response selection represented by the slope of the function.[1] As discussed in the introduction, functions

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[1]This conclusion does not depend upon acceptance of the complete model proposed by Sternberg (1969). Specifically, one need not assume that the linear dependence of reaction time on the number of alternative targets indicates a serial process such as memory scanning. An alternative model described by Anderson (1973) and by Lappin (1978) attributes such effects to the statistical charcteristics of the stimuli without postulating any limitation on perception or memory. The interested reader should consult Lappin's (1978) article as well as the following brief update.

The specific model of Lappin (1978) assumes that the discrimination between alternative targets derives from numerous stochastically independent perceptual events added to uncorrelated "noise." By also assuming that successive perceptual events are stochastically independent in time, it was shown that such a model predicts the well-known linear relation between number of alternative targets and reaction time in the Stenberg binary classification task without postulating any processing limitation such as serial memory scanning. However, the same simple model will not account for the additivity of stimulus discriminability and number of alternative targets observed in the present experiments and in Sternberg (1967), contrary to the suggestion of Lappin (1978). If the signal/noise ratio of each component perceptual event depends upon the stimulus discriminability (e.g., if the signal/noise ratio were lower for stereoscopic than for physical events), and if the same signal/noise ratios determine the increase in reaction time due to increases in number of targets, then stimulus discriminability and number of targets would have multiplicative (not additive) effects. The increase in reaction time due to increasing numbers of targets would be greater for the stimuli that are

that yield common slopes can be interpreted to mean that the perceptual processes they represent are not influenced by prior knowledge, with prior knowledge defined as the number of target alternatives. Accordingly, it is necessary to conclude that the present results demonstrate that prior knowledge exerts no influence on the time required to perceive random-element stereograms. The only difference between stereoscopic forms and their physical-contour counterparts is in their initial discriminability. Physical forms are discriminated more rapidly than stereoscopic forms, although the difference, at least for some observers, is not very great (see results of Experiment 2).

Even though the conclusion of no effect of prior knowledge may seem to run counter to anecdotal evidence and casual observation, it is quite congruent with formal models that have been developed to account for global stereopsis (Julesz, 1971; Julesz & Chang, 1976; Marr & Poggio, 1976; Sperling, 1970; Sugie & Suwa, 1977). Although these models invoke a variety of metaphor magnets, hypothetical neurons, computer programs--they have in common a machinery that automatically and inexorably processes stereoscopic information. No room is left for the operation of such cognitive variables as prior knowledge. So, on this point, the present results provide general support for current models.

Finally, as a somewhat parenthetic yet parallel comment, there is a common belief that prior knowledge can directly influence the perception of physical-contour stimuli, as opposed to influencing subsequent decision and response-selection stages. Yet that belief has been difficult to demonstrate rigorously, and some work (Lappin & Staller, 1977, Note 2; Lappin & Uttal, 1976; Staller & Lappin, 1979) reveals specific instances where it is not true.

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more slowly and less accurately perceived. Since the increase in reaction time due to an increase in the number of targets was the same for stereoscopic as for physical contours in the present study, it must be concluded that stereoscopic presentation and number of alternative targets influence different and presumably temporally separate processes.

REFERENCE NOTES

1. Julesz, B., & Kropfl, W. J. Increased reaction time to dynamic stereograms without monocular cues. Paper presented at the Meeting of the Psychonomic Society, St. Louis, November 1973.

2. Lappin, J. S., & Staller, J. D. Prior knowledge does not aid the detection of coherent motion of dynamic random-dot patterns. Paper presented at the Meeting of the Psychonomic Society, Washington, November 1977.

REFERENCES

Anderson, J. A. A theory for the recognition of items from short memorized lists. Psychological Review, 1973, 80, 417-438.

Cleveland, W. S., & Guarino, R. The use of numerical and graphical statistical methods in the analysis of data on learning to see complex random-dot stereograms. Perception, 1978, 7, 113-118.

Fox, R., Lehmkuhle, S., & Leguire, L. E. Stereoscopic contours induce optokinetic nystagmus. Vision Research, 1978, 9, 1189-1192.

Frisby, J. P., & Clatworthy, J. L. Learning to see complex random-dot stereograms. Perception, 1975, 4, 173-178.

Julesz, B. Foundations of cyclopean perception. Chicago: University of Chicago Press, 1971.

Julesz, B., & Chang, J. J. Interaction between pools of binocular disparity detectors tuned to different disparities. Biological Cybernetics, 1976, 22, 107-119.

Lappin, J. S. The relativity of choice behavior and the effect of prior knowledge on the speed and accuracy of recognition. In F. Restle & N. Castellan (Eds.), Cognitive theory (Vol. 3). Hillsdale, N.J.: Erlbaum, 1978.

Lappin, J. S., & Uttal, W. Does prior knowledge facilitate the detection of visual targets in random noise? Perception and Psychophysics, 1976, 20, 367-374.

MacCracken, P. J., & Hayes, W. N. Experience and the latency to achieve stereopsis. Perceptual and Motor Skills, 1976, 43, 1227-1231.

MacCracken, P. J., Bourne, J. A., & Hayes, W. N. Experience and latency to achieve stereopsis: A replication. Perceptual and Motor Skills, 1977, 45, 261-262.

Marr, D., & Poggio, T. Cooperative computation of stereo disparity. Science, 1976, 194, 283-287.

Ramachandran, V. S. Learning-like phenomenon in stereopsis. Nature, 1976, 262, 382-383.

Ramachandran, V. S., & Braddick, O. Orientation-specific learning in stereopsis. Perception, 1973, 2, 371-376.

Saye, A., & Frisby, J. P. The role of monocularly conspicuous features in facilitating stereopsis from random-dot stereograms. Perception, 1975, 4, 159-171.

Sperling, G. Binocular vision: A physical and a neural theory. American Journal of Psychology, 1970, 83, 461-534.

Staller, J. D., & Lappin, J. S. Word and nonword superiority effects in a letter detection task. Perception and Psychophysics, 1979, 25, 47-54.

Sternberg, S. Two operations in character recognition: some evidence from reaction-time measurements. Perception and Psychophysics, 1967, 2, 45-53.

Sternberg, S. The discovery of processing stages: extensions of Donders' method. In W. G. Koster (Ed.), Attention and performance II. Acta Psychologica, 1969, 30, 276-315.

Sugie, N., & Suwa, M. A scheme for binocular depth perception suggested by neurophysiological evidence. Biological Cybernetics, 1977, 26, 1-15.

Woodworth, R. S. Experimental psychology. New York: Holt, 1938.

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